Ohio Academy of Science

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May 1-3, 1992

Geology Section Field Trip

Environmental Geology of the Cuyahoga River

May 3, 1992

Title page constructed from information in the Ohio Journal of Science, v. 92, no. 2.

Geology Section Field Trip

The 1992 OAS geology field trip includes numerous stops along the Cuyahoga River that illustrate the river's geologic history, environmental problems and present significance as a water supply and treated wastewater conveyor. Glacial outwash, Kent end moraine, bedrock and channel characteristics of the upper Cuyahoga will be compared and contrasted with lacustrine deposits, bedrock and channel characteristics of the lower Cuyahoga. Trippers attention will be directed to several of the data collection stations mentioned in the May 1, 1992 Cuyahoga River Symposium. If time permits, a stop will be made at the Independence USGS stream gauging station and/or the navigation channel in "the Flats" of Cleveland.

Dr. Jim L. Jackson, The University of Akron, Department of Geology

Road Log
Environmental Geology of the Cuyahoga River
3 May 1992

Two handouts: Cuyahoga River by Olive and Jackson
Summary Report RAP

Mileage

0.0	Assembly area - Student Parking Lot on east side of University of Akron campus adjacent to Route 8 North Expressway and Buchtel Ave. and Carroll Street.
	Akron, the "City at the Summit", developed here because of water power, canal transportation 1837-1913, railroads 1850's to present, good water supplies, coal, and industrious people. Glaciers modified earlier drainage systems by partially burying valleys and shifting drainage divides. Let's look at some examples.
0.0 - 0.8	East on Buchtel Ave. to Arlington St. Turn left, north, onto Arlington St.
0.8 - 1.0	Turn right at the next traffic light onto Hazel Street.
1.2	Cross the Little Cuyahoga River and railroad track.
	The Little Cuyahoga River is flowing over a buried valley tributary to a preglacial drainage system, Dover River, with headwaters south of New Philadelphia. The buried valley aquifer and surface infiltration can supply 62 million gallons of ground water to Goodyear Tire 1.8 miles to the southeast, upstream today. Well fields from the buried Dover River drainage also provide water to Firestone Tire, and others.
1.5 - 1.6	Note closed landfill on the left. Flare burns methane from the landfill gases. New homes on the right are subsidized housing. The landfill was developed in a kame terrace and outwash.

1.9 Turn sharp left onto Eastwood. Closed landfill on left. Proposal to expand to the north, right side, was denied several years ago because of highly permeable material and large volumes of water in the subsurface north of the RR tracks.

1.9 - 2.7 Interesting driving through relatively inactive rail yards. Don't forget to inhale at the underpass.

2.7 Turn left on North Street proceed through traffic light and turn right on Dan Street. Near the top of the hill is a closed landfill in outwash. Kenmore Construction now uses the site for equipment and supply storage. A passive methane gas control system was adequate here because the waste was not deep, aeration through the sand and gravel inhibited anaerobic bacteria.

3.5 Turn left off Dan Street onto Crawford and immediately turn right onto Gorge Blvd. Drive parallel to the North Expressway.

4.7 Turn left, under the expressway, then a gentle right down to the bridge to the west of the now inactive Gorge Power Plant.

5.0 Cross Cuyahoga River and continue on Front Street to observation.

6.0 Observation Bridge - Stop One. Discussion on bridge.

The Sharon Sandstone, here the lowest unit in the Pennsylvanian Pottsville Formation, has fracture sets that contributed to development of a small tributary to the Dover River. The upper Cuyahoga "discovered" the tributary and was diverted westward to the ancestral, Dover River, channel and turned north because the ice dams were gone.

Picture the 1800's and the water, later steam driven, industries that lined both sides of the river here at Cuyahoga Falls. A dam was built just downstream for hydroelectric power. The small power plant provided electricity to trolleys and local environs. It was removed

TABLE 2.—*Generalized geologic section of the consolidated rocks in Portage County*

	Thickness (feet)
Pennsylvanian:	
Pottsville Formation:	
Homewood Sandstone Member	0–100
Mercer Member	0– 90
Tionesta coal.	
Upper limestone unit.	
Bedford coal.	
Lower limestone unit.	
Middle Mercer coal.	
Lower Mercer coal.	
Connoquenessing Sandstone Member	0–140
Sharon Member:	
Shale unit	0– 90
Quakertown coal.	
Sharon coal.	
Conglomerate unit	0–250
Mississippian:	
Cuyahoga Group	5–250
Meadville Shale.	
Sharpsville Sandstone.	
Orangeville Shale.	
Berea Sandstone	0– 75
Mississippian and Devonian	600+
Bedford Shale.	
Cussewago Sandstone.	
Ohio Shale (Cleveland Member).	
Chagrin Shale.	

Winslow, John D. and George W. White. 1966 Geology and Ground-Water Resources of Portage County, Ohio. Geological Survey Professional Paper 511, Washington D.C. pg. 7.

about 1950. The Gorge Plant, coal fired, was larger and more efficient. The dam provided a pool for cooling water until the Gorge Plant was shut down last year. The dam is at river mile 45.1 about 1/2 mile downstream. The dam rests on the Sharpsville Ss, about 100 feet below the base of the Sharon Ss. The Meadville Shale inhibits leakage.

We'll have a brief stop at Sheraton Suites.

6.2 Continue north of Front St. (0.2 mi) to Broad Blvd. Left, west, cross State Road to 26th St.

7.8 Turn left onto 26th then bear right onto Sackett, and immediately turn left into Babb Run Park.

8.0 Stop Two

Babb Run park is on lacustrine and fluvial (deltaic) material of Glacial Lake Cuyahoga. Erosion has been a major problem here. Stop 2 illustrates fine-textured, easily eroded material that dominates the lower Cuyahoga River. We are 44 river miles from Lake Erie. Face west and note the cut in the silts. Oxidation or lack thereof accounts for buff, red or gray colors in the silts. The stream-cut terrace on which you are standing has an elevation of 860 feet.

8.0 Leave Babb Run, carefully turn left. Note evidence of breaks in the road and lower material.

8.5 Turn right on Cuyahoga Street. Drive north to Portage Trail, first traffic light.

9.4 Turn left, west on Portage Trail. Descend into the lower Cuyahoga River to Akron-Peninsula Rd.(A-P Road). Note the new shopping center on flood plain.

10.5 Turn right, north on A-P Road. Dams upstream decrease the chance of flooding here, but ... Old Portage gaging station is near the bridge on A-P Road. Had we turned left, south, we would have seen it.

Proceed north on A-P Road to the Akron Waste Water Pollution Control Station. (WWPCS)

12.2 Stop 3. We'll look at monitoring wells and outwash terrace to the east (about 810 feet above sea level). We're standing at 750'. 15 feet below begins a layer of lacustrine silt and clay over 150' thick. At 169' a layer of gravel produced a flowing artesian well. The lacustrine material and the hydrology of the silts are important to the landfill on the terrace to the east. Akron's WWPCS treats an average of 65-70 million gallons of sewage per day.

Tributaries to the lower Cuyahoga River, Furnace Run, Yellow Creek, Tinkers Creek and others contribute an inordinate amount of sediment to the river. Part of the sediment reaches the navigation channel in Cleveland. See U.S. Army Corps data on following pages for details, especially Table 8. Lateral erosion is also a problem as meanders begin to intersect roads. I've watched one shift over 175 feet in 15 years.

12.7 Continue north on A-P Road.

12.9 Turn right, east, on Bath Road. Notice terraces on the right. Terrace materials filtered fluids from sludge placed in extensive lagoons developed on the terraces until the practice stopped several years ago.

13.4 Turn right on Steels Corners Road. Note slope failure on the right.

15.0 Note entrance to Blossom Music Center, "summer home" of the Cleveland Orchestra.

15.7 Intersection with Northampton Road, left turn, north. This area will develop further because waterlines have been extended into the area. Local oil and gas wells are about 3900 feet deep and produce from the "Clinton" with some

Table 8 - Summary of Total Soil Dislodged Sediment vs. Total Soil Dislodged From Critical Areas for Each Subwatershed 1/

Subwatershed	Total Tons of Soil Dislodged/ Year	Total Sub-watershed Acreage	Total Tons of Soil Dis-lodged from Critical Areas/Year	Total Critical Area Acreage
Mud Brook	60,871	18,752	57,317	1,395
Tinkers Creek	173,098	54,784	160,499	5,750
Chippewa Creek	88,607	11,328	85,719	1,804
Furnace Run	180,507	11,328	175,341	2,583
Local Drainage	376,035	60,672	366,213	12,922
Brandywine Creek	33,916	17,408	29,215	900
Yellow Creek	14,488	19,648	9,083	1,352
Total Area	927,522	193,920	884,387 3/	26,706
	(say 928,000 tons or 620,000 cy/yr) 2/	(say 194,000)	(say 884,000 4/ tons or 590,000 cy/yr) 2/	(say 27,000 acres 5/

1/ Critical areas are defined as those areas which have actual sediment dislodgement above the tolerable soil loss value.
2/ Assumed unit weight of 110 lbs. per cubic foot.
3/ Of this 885,000 tons of soil dislodged (590,000 cy) it is estimated that 551,000 tons (or 368,000 cy) is delivered to the Cuyahoga River system annually.
4/ 95 percent of the total soil dislodged.
5/ 14 percent of the total area acreage.

U.S. Army Corps of Engineers. 1982 Cuyahoga River, Ohio Restoration Study Supplement Report to the Third Interim Preliminary Feasibility Report on Erosion and Sedimentation. Buffalo, New York. pg. 20.

Table 9 - Summary of Critical Erosion Areas by Land Use 1/

Land Use	Total Acreage of Critically Eroding Area in Each Category	Total Site Dislodged from Critical Areas for Each Category (tons/year)	Dislodgement in Each Category as Percentage of Total Dislodgement (percent)	Estimated Delivery Rate to Cleveland Harbor (Percent)	Delivered Tons/Year
Commercial-Industrial	1,165	26,520	3	50	13,260
Community Services	910	20,979	2	30	6,293
Cropland	958	13,975	2	20	2,795
Pastureland	206	1,383	-	10	139
Recreation Land	440	49,873	6	70	34,912
Transportation Land	351	1,936	-	50	968
Wildlife Land	1,903	43,182	5	40	17,272
Woodland	16,572	581,262	66	70	406,883
Other Land	2,404	126,267	14	50	63,134
Residential Land	1,747	18,740	2	30	5,622
Hayland	50	270	-	10	27
Total	26,706 (say 27,000)	884,387 (say 884,000)	100		551,305 (say 551,000)

1/ 14 percent of the 193,920 acres in total study area.

U.S. Army Corps of Engineers. pg. 22.

production from the Newburg, which may be "sour". Deep water wells, over 100', generally encounter brackish water in an equivalent to the Berea Ss.

Enjoy the slightly hummocky end moraine. As we drop back into the valley, note the steep sides due to vertical jointing in the lake silts. The road is a bit narrow.

18.1 Intersection of Northampton Road with A-P Road. Turn right, north. Honest, we are on our way to the a rest stop and lunch.

20.5 Turn right, east, on Route 303 and proceed east to the Happy Days Visitor Center, National Park Service (NPS).

20.7 Lunch - Park in visitors' lot and carry lunch over to visitors' center and RESTROOMS.

After lunch is decision time. The number of people, length of car caravan, time of day, etc. will be considered. As I write this, I'm predicting we should go to Lake Rockwell and a small part of the upper Cuyahoga.

0.0 Reset Trip Odometers

Go east, left out of the NPS parking area on Route 303. Just east of the Rt. 8 expressway,

1.1 turn right on Terex Road.

4.1 Cross Rt. 91, Darrow Road. Note the old Terex Plant has new occupants.

6.3 Little Tikes - Several months ago I helped with a group of touring Russians. They were interested in polymers. After campus tour, I brought them here. Toys over weapons!

7.6 Cross Stow Road.
Note the significant number of boulders typical of end moraine on the right.

7.9 Gentle left turn.

9.4 Turn left and go through railroad overpass.

9.8 Turn right on Ravenna Road.

11.0 Turn right on Rt. 43, cross RR bridge and turn left onto Ravenna Road.

11.6 Akron Water Treatment Plant
Brief stop or go on

11.9 Turn left into private drive to view Lake Rockwell Dam.

Lake Rockwell was built in 1913 in response to poor water quality some 15 miles away in Akron. There are now two aqueducts to carry water to Akron and some suburbs. An average of 45,000 g/d is processed and pumped toward Akron from here. When tires were still being built in Akron and when water cost less, the production here was 51,000 g/d. The capacity of the system here and the reservoirs upstream could be doubled without major changes. Few other cities of the world can make that statement.

Sand and gravel in outwash and kame moraine, bogs and other wetlands, and reservoirs all do their part to limit rapid runoff. They also enhance water quality in most respects. Some reduction of dissolved oxygen can be attributed to reservoirs and wetlands.

Sand and gravel production (1991) was worth $12,597,421 in Portage County, Summit County sales were $2,276,484, Geauga County sales were nearly 2 million dollars.

Reservoirs on the upper Cuyahoga

Lake Rockwell - Spillway Elev. (without boards) is 1052 feet.

LaDue Reservoir - Spillway Elev. 1125 feet. LaDue is on Bridge Creek, a tributary to the Cuyahoga River.

East Branch Reservoir - 1132 feet.

Broad wetlands occur where preglacial valleys have been filled, and the present river has a very gentle gradient controlled by a preglacial sandstone ridge, i.e. Hiram Rapids where the channel is narrow and has a bedrock bottom while above Hiram Rapids the Cuyahoga is so sluggish that canoers get tired.

The source of the Cuyahoga River is north and west of Montville, a crossroads of U.S. Rt. 6 and State Route 528 at an elevation about (300 feet). Lake Erie is about 571 feet.

11.9 Now drive around Lake Rockwell by taking left turns at every public road available. Think Kent end moraine and good water due in part to the City of Akron owning about 18,000 acres of the upper Cuyahoga drainage basin.

Thanks for your interest in the Cuyahoga.

CUYAHOGA RIVER, OHIO RESTORATION STUDY
THIRD INTERIM PRELIMINARY FEASIBILITY REPORT
ON
EROSION AND SEDIMENTATION

APPENDIX B

HYDROLOGY AND HYDRAULIC DESIGN

B1. INTRODUCTION

The Cuyahoga River is about 100 miles long and drains some 810 square-miles of northeastern Ohio as shown on Figure B1.1. The river begins at an elevation of about 1,300 feet, several miles northeast of Burton in Geauga County, and flows in a southerly direction towards Hiram Rapids, where the direction changes southewesterly through Mantua, Kent, and Cuyahoga Falls, to the confluence with the Little Cuyahoga River at Akron. From Akron, the river flows north to Cleveland, to an elevation of about 570 feet. The lower 5.8 miles are part of an existing Federal navigation project for Cleveland Harbor, one of Lake Erie's major ports.

The main tributaries of the Cuyahoga River are: Big, Mill, Tinkers, and Chippawa Creeks; Mud Brook, Little Cuyahoga River, Congress Lake outlet (Breakneck Creek), and West Branch Cuyahoga River. The overall basin consists of rolling hills and many natural small lakes and ponds. A relatively distinct escarpment near Cleveland divides the basin between an upland plateau and the narrow lake plain.

B2. HYDROLOGY

a. GENERAL - The information presented in this section has been prepared from data contained in the Corps of Engineers reports entitled, "Review of Reports for Flood Control and Allied Purposes, Cuyahoga River, Ohio (September 1969)" and the "Second Interim Feasibility Report on Cuyahoga River Flood Control Study (March 1976)." The data contained in these reports has not been undated for this preliminary feasibility investigation. Therefore, if the recommendation of this report is to continue into Stage 3 planning, additional study will be required.

b. CLIMATOLOGY - Available data from 34 climatological stations with varying lengths of record in and around the Cuyahoga River Basin, were used in studies of past storms. Eight of these stations are presently in operation. Records from these eight were used in compiling climatological data for the basin. Two of them are located within the basin and the other six are adjacent to it, including first order weather bureau stations at Cleveland Airport and Akron-Canton Airport. The locations of all climatological stations are shown on Figure B2.1. The period of record, type, and location of stations now in operation are given in Table B2.1.

c. PRECIPITATION 1/ - The weighted average annual precipitation for the eight climatological stations in and adjacent to the river basin is 36.70 inches. The weighted monthly averages vary from a minimum of 2.35 inches for

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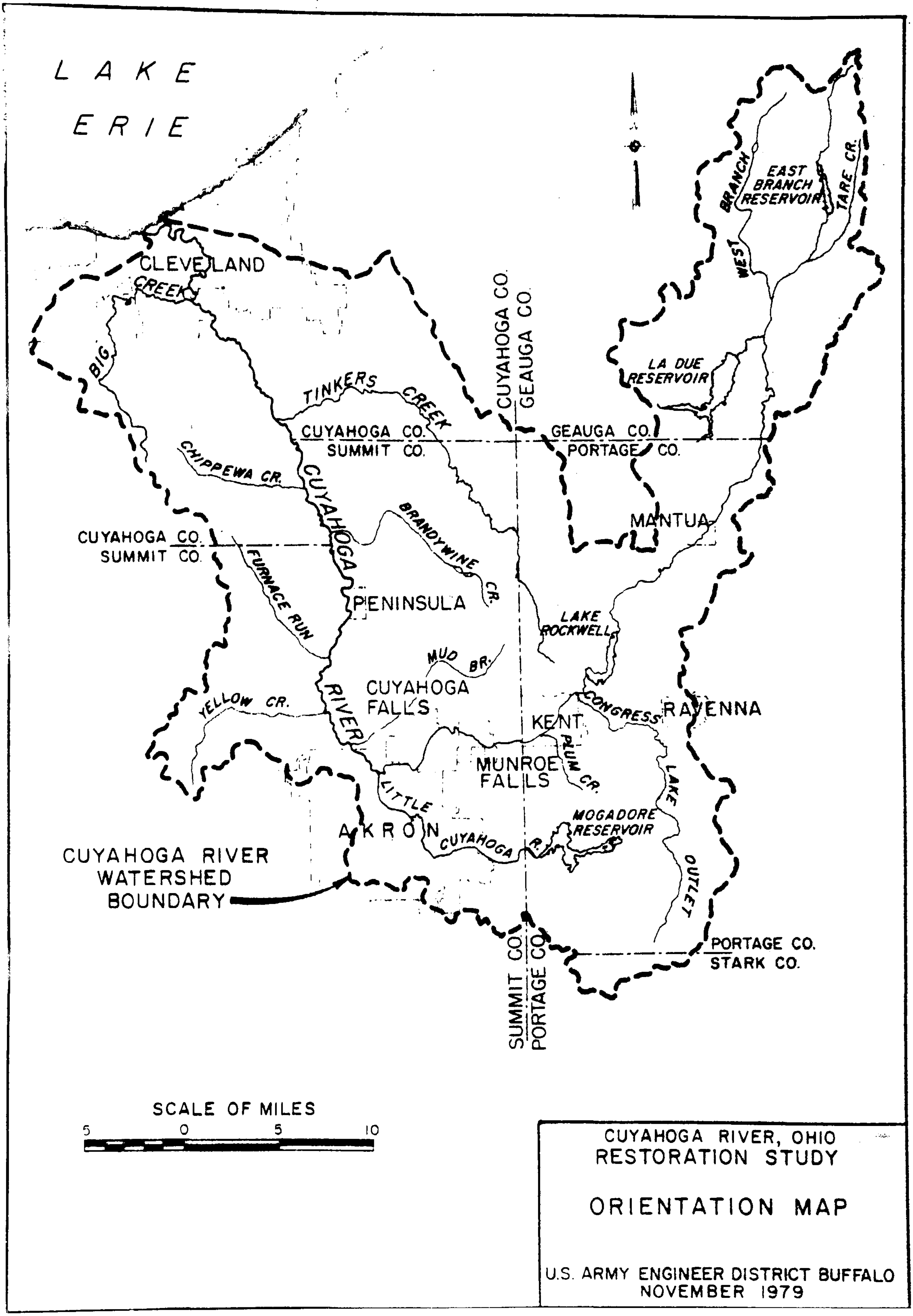
1/ Data based on years of record through 1968.



CUYAHOGA RIVER, OHIO
RESTORATION STUDY

ORIENTATION MAP

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

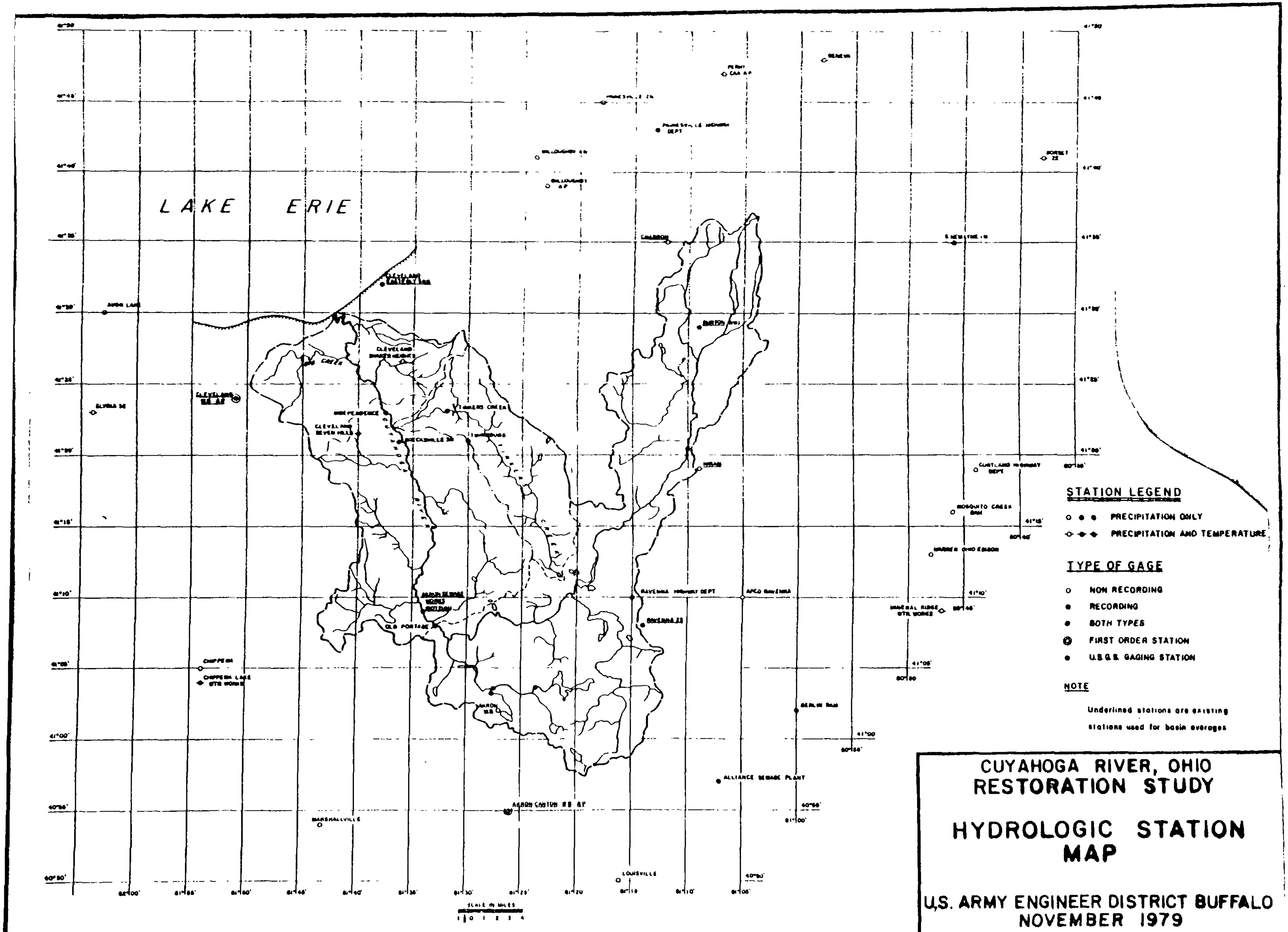

LAKE ERIE
STATION LEGEND
PRECIPITATION ONLY
PRECIPITATION AND TEMPERATURE
TYPE OF GAGE
NON RECORDING
RECORDING
BOTH TYPES
FIRST ORDER STATION
U.S.G.S. GAGING STATION
NOTE
Underlined stations are existing stations used for basin averages
RAVENNA
OLD PORTAGE
AKRON CANTON WB AP
ALLIANCE SEWAGE PLANT
MARSHALLVILLE
LOUISVILLE
CHIPPEWA
BERLIN DAM
MOSQUITO CREEK DAM
WARREN OHIO EDISON
CORTLAND HIGHWAY DEPT
INDEPENDENCE
APCO RAVENNA
CUYAHOGA RIVER, OHIO
RESTORATION STUDY
HYDROLOGIC STATION MAP
U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1979

FIGURE B2.1

Table B2.1 - Climatological Stations in and Adjacent to the Cuyahoga River Basin 1/

Station Name	Index Number	Location				Type of Record (1)	Length of Record in Years (2)
		County	Latitude	Longitude	Elevation		
Akron Canton W. B. Airport	0058	Summit	40°-55'	81°-26'	1,208	R,P,T,S	21 (3)
Akron Sewage Works	0059	Summit	41°-09'	81°-34'	760	R,P	20 (4)
Burton (1W)	1113	Geauga	41°-28'	81°-10'	1,160	R,P	18 (4)
Chardon	1458	Geauga	41°-35'	81°-12'	1,260	NR,P,T,S	23 (3)
Cleveland Easterly Swg	1651	Cuyahoga	41°-32'	81°-38'	592	R,P	13 (4)
Cleveland W. B. Airport	1657	Cuyahoga	41°-24'	81°-51'	777	R,P,T,S	96 (4)
Hiram	3780	Portage	41°-19'	81°-09'	1,260	NR,P,T,S	88 (3)
Ravenna (2S)	6949	Portage	41°-08'	81°-14'	1,100	R,P	21 (3)

(1) Type of record code: R = recording, NR = non-recording, P = precipitation, T = temprature, S = snowfall.

(2) All stations now in operation.

(3) Years of record through 1968.

(4) Years of record through 1967.

1/ SOURCE: Table from Corps 1969 report.

February to a maximum of 3.65 inches in April. The highest average monthly precipitation, 4.49 inches, occurs at Chardon in April, whereas the lowest average monthly precipitation, 1.71 inches, occurs at Cleveland Easterly Sewage Plant in December. Average annual precipitation varies from 30.62 inches at Cleveland Easterly Sewage Plant to 44.20 inches at Chardon. The monthly and yearly averages for each station are tabulated in Table B2.2.

d. SNOWFALL [1/] - The weighted average annual snowfall recorded at the four snowfall stations is 58.1 inches. Chardon has the highest average annual snowfall, 109.3 inches. Individual averages for the stations are shown in Table B2.3.

e. TEMPERATURE - The weighted average annual temperature in the river basin is 49.1 degrees Fahrenheit. January is the coldest month with an average temperature of 27.3 degrees, and July is the warmest month with an average temperature of 71.2 degrees. Average monthly and yearly temperatures for each of the four stations are listed in Table B2.4.

f. NOTABLE STORMS - Storms which resulted in serious flooding in the Cuyahoga River Basin include those of March 1913, June 1947, January 1952, October 1954, and January 1959.

(1) March 1913 Flood - The greatest precipitation, and the most destruction from high winds and floods to occur any month for which records are available, occurred in March 1913. Heavy rains occurred during the periods 13-15 and 20-21 March. These rains were only preliminary to the severe storm which developed during the period of 23-27 March. This storm extended from Texas to Lake Erie with its center over Bellefontaine, OH, 125 miles southwest of the Cuyahoga Basin. Two low-pressure centers combined to form a long trough of low pressure which caused excessive rainfall in Ohio and neighboring States for about 60 hours. Bellefontaine recorded a total of 11.16 inches of rainfall in 92 hours.

The Cuyahoga River Basin lay under the northeast edge of the storm and received an average of 8.86 inches of rainfall during the storm period. The estimated peak discharge, 30,000 cfs, for the March 1913 flood was determined by reconstitution of the flood hydrograph at the Independence gage site from rainfall records and unit hydrographs. Estimates of initial loss, infiltration, and base flow were included in the study. Total runoff at the gage site was estimated to have been 5.81 inches. The frequency of occurrence of a flood of such magnitude is estimated as less than once in 200 years.

[1/] Data based on years of record through 1968.

Table B2.2 - Average Monthly Precipitation 1/

Station	Years of Record	Precipitation, in Inches												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Akron Canton W. B. Airport	21	2.82	2.21	3.45	3.36	3.84	3.65	3.55	3.20	2.60	2.34	2.48	2.43	35.93
Akron Sewage Works	20	2.74	2.46	3.04	3.84	2.90	3.09	3.54	2.93	2.69	2.06	2.47	2.19	33.95
Burton (1W)	18	2.58	2.44	3.21	3.96	3.13	3.19	3.38	3.27	2.99	2.82	3.00	2.42	36.39
Chardon	23	3.54	2.78	3.82	4.49	3.90	3.88	3.72	3.94	3.02	3.66	4.12	3.33	44.20
Cleveland Easterly Swg.	13	1.93	1.77	2.13	3.39	2.93	3.21	3.11	3.20	2.26	2.31	2.67	1.71	30.62
Cleveland W. B. Airport	96	2.65	2.33	3.12	3.41	3.49	3.37	3.30	3.28	2.85	2.40	2.61	2.35	35.16
Hiram	88	2.84	2.39	3.32	3.71	3.94	4.03	3.69	3.40	2.94	2.77	2.87	2.61	38.51
Ravenna (2S)	21	2.88	2.16	2.91	3.59	3.41	3.41	3.94	3.02	2.58	2.25	2.93	2.32	35.40
Weighted Average		2.77	2.35	3.20	3.65	3.59	3.59	3.52	3.31	2.83	2.59	2.83	2.47	36.70

1/ SOURCE: Table from Corps 1969 report.

Table B2.3 - Average Monthly Snowfall 1/

Station	Years of Record	Snowfall, in Inches												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Akron Canton W. B. Airport	21	10.5	9.3	9.6	2.6	0.1	T				0.5	5.6	9.6	47.8
Chardon	23	25.2	21.2	18.6	5.2	T		T	T	T	1.1	13.5	24.5	109.3
Cleveland W. B. Airport	21	10.7	10.8	10.6	2.1	T					0.8	6.3	9.8	51.1
Hiram	72	9.8	10.3	7.0	2.4	T	T	T		T	0.7	5.7	10.8	46.7
Weighted Average		12.6	12.0	9.9	2.9	T	T	T	T	T	0.8	7.1	12.8	58.1

T = Trace

1/ SOURCE: Table from Corps 1969 report.

Table B2.4 - Mean Monthly Temperatures 1/

Station	Years of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
		Temperature, in Degrees Fahrenheit												
Akron Canton W. B. Airport	21	27.0	27.1	35.8	47.7	58.2	68.2	71.6	70.2	63.4	52.2	40.3	30.3	49.3
Chardon	23	26.1	27.2	35.4	47.6	57.3	67.1	70.8	69.4	63.3	53.5	40.9	29.4	49.0
Cleveland W. B. Airport	97	27.6	28.0	35.4	46.7	57.5	67.3	71.0	69.4	62.5	51.8	39.5	29.6	48.8
Hiram	84	27.5	27.6	35.4	47.5	58.2	67.7	71.5	70.0	63.7	53.1	40.5	29.9	49.4
Weighted Average		27.3	27.7	35.4	47.2	57.8	67.5	71.2	69.7	63.1	52.5	40.1	29.8	49.1

1/ SOURCE: Table from Corps 1969 report.

(2) January 1959 Flood - The greatest flood in recent years occurred on 22 January 1959. The January 1959 storm caused severe damage not only in the Cuyahoga River Basin but throughout the State of Ohio. The storm developed from a large mass of cold air over northwestern Canada, a flow of warmer air from the southwest and the associated frontal system. Heavy rains began on the 20th when the moisture-laden air from the south converged with the cold front. Although total rainfall for the storm was not excessive, intensities were high and runoff was increased by the frozen ground and the six-inch snow cover on the basin. The storm was centered approximately 150 miles southwest of the Cuyahoga River Basin and rainfall averaged 2.34 inches over the basin. Runoff from rainfall and snow melt averaged 2.94 inches. The United States Geological Survey (USGS) gaging station at Independence was inaccessible during the flood. A peak discharge of 24,800 cfs was calculated by the Geological Survey by contracted opening formula using high water marks at Hillside Road Bridge, 1.7 miles upstream of the gage. To check the reasonableness of the USGS peak discharge estimate, the flood was synthetically reconstituted by the Buffalo District. The synthetic peak discharge thus determined was 23,000 cfs. This check on the USGS calculations indicates that both solutions provide values which fall within narrow limits and which appear reasonable, based on the data used. The difference between the two solutions is probably the result of one or a combination of the following: false high water marks at Hillside Road Bridge caused by backwater effect from ice and debris dams; non-uniform area distribution of rainfall upstream of the gage causing the rainfall estimate to be low; or a low estimate of snow melt contributing to the flow. The January 1959 Flood on the Cuyahoga River is considered to be of Intermediate Regional Flood magnitude (100-year frequency).

(3) October 1954 Flood - Precipitation during the month of October 1954 was frequent and often heavy over the Cuyahoga River Basin. Many stations experienced record high precipitation for the month. Moderate to heavy rains fell over the basin during the period 10-14 October. A cold front moving from west to east through Ohio during the night of 14-15 October caused showers and thunderstorms over the basin. As the cold front reached the eastern border of Ohio, hurricane "Hazel" was approaching the Carolina coast, and the rain associated with the cold front was almost entirely west of the front. The hurricane's rain area spead rapidly inland and northward during the morning of the 15th to merge with the frontal rain before noon. Torrential rain fell in northeastern Ohio during the afternoon and evening of the 15th. Average rainfall over the basin was 4.47 inches and the total runoff at the Independence gage was estimated to have been 2.72 inches.

g. RUNOFF AND STREAM FLOW DATA - The United States Geological Survey has installed and operated 14 water-stage recording stations on the Cuyahoga River and its tributaries. Of these, seven were in operation when the Second Interim Report was prepared (1976). Peak discharges and runoff per square mile for four floods on the Cuyahoga River is given in Table B2.5 for each of these stations.

Table B2.5 - USGS Stage-Recording Gages in the Cuyahoga River Basin 1/

Stream	Location	Drainage area sq. mi.	Period of Record Years	Maximum Flood Discharge Peaks June 1947 cfs	cms 2/	January 1952 cfs	cms 2/	October 1954 cfs	cms 2/	January 1959 cfs	cms 2/
Cuyahoga R.	Hiram Rapids, OH	151	1927-1935 1944-1974	1,510(1)	10.0	2,380	15.8	1,980	13.1	3,670	24.3
Cuyahoga R.	Old Portage, OH	404	1921-1035 1939-1974	3,100	7.7	4,540	11.2	2,180(1)	5.4	6,500	16.1
Cuyahoga R.	Independence, OH	707	1921-1923 1927-1935 1940-1974	12,600	18.0	11,200	16.0	14,200	20.2	24,800(4)	35.1
Little Cuyahoga	Mogadore, OH	17.3	1946-1974	143	10.0	136	9.5	27(1)	1.9	97	6.8
Ohio Canal	Independence, OH	None	1921-1923 1927-1935 1940-1974	70		88		145		277	
Big Creek	Cleveland, OH	35.3	1972-1974	N/A		N/A		N/A		N/A	
Tinkers Creek	Bedford, OH	83.9	1962-1974	(2)		(2)		6,150(3)	73.3	(2)	

1/ SOURCE: Second Interim Report.

2/ csm - Cubic feet per second per square mile.

(1) Estimated by U. S. Army Corps of Engineers, Buffalo District

(2) Gage was not in operation.

(3) Estimated from storm studies.

(4) Includes Ohio Canal discharge.

SECTION IV

SUMMARY AND GENERAL CONCLUSIONS

GENERAL

The purpose of this Supplemental Report and the Preliminary Feasibility Report (PFR) was to present a summary of the results of the planning effort conducted since initiation of the erosion and sedimentation study. This planning effort included detailed studies to identify and quantify the major sources of sediment in the Cuyahoga River watershed, and formulation and assessment of a wide range of alternative measures for addressing the erosion and sedimentation problems of the area.

The harbor at Cleveland, OH, consists of a breakwater protected Lakefront Harbor in Lake Erie and improved navigation channels on the Cuyahoga River and Old River. When sediment carried by the Cuyahoga River reaches the relatively quiet waters of the navigation channel and Lakefront Harbor, it deposits sediments and forms shoals. These shoals must then be removed by maintenance dredging costing approximately $4,000,000 per year. (NOTE: Does not include additional cost of providing diked disposal facilities required because the dredged sediment is heavily polluted based on present U.S. Environmental Protection Agency standards.) Also, in addition to the annual cost for dredging the navigation channels and Lakefront Harbor, sediment accumulation presents severe problems to commercial interests utilizing the harbor facilities. Since dredging is normally not concluded until July, vessels must reduce their load in the Lakefront Harbor before proceeding upriver; also, sediment enters the ship's ballast system and accumulates until the ship is laid up.

Although the Cuyahoga River drains an area of approximately 810 square miles, the scope of this study was directed towards identifying the sources of erosion and determining the feasibility of providing erosion control measures in the 303 square-miles of the Cuyahoga River Basin between Independence, OH, (river mile 13.8) and Old Portage, OH, (river mile 40.25). This reach of the river was identified by Dr. Robert Apman in his report on "Erosion and Sedimentation of the Cuyahoga River Basin" (1973) as the most prolific source of sediment in the river system. Dr. Apmann's findings were subsequently confirmed by a 1-year suspended sediment data collecting program conducted by the U.S. Geological Survey.

A summary of the results of the erosion and sedimentation studies follows.

U.S. Army Corps of Engineers. pg. 92.

SUMMARY RESULTS OF STREAMBANK EROSION CONTROL STUDIES

The purposes of the streambank erosion control studies conducted for this study were to identify and quantify sources of streambank erosion and to determine the feasibility of implementing streambank erosion control measures in the channel component study area. The channel component study area consisted of the main stem (main channel) of the Cuyahoga River between Independence, OH, (river mile 13.8) and Old Portage (river mile 40.25) and the channels of the six major tributaries in this reach. These tributaries are Mud Brook, Brandywine Creek, and Tinkers Creek on the east side of the basin and Yellow Creek, Furnace Run and Chippewa Creek on the west side of the basin.

Results of the studies (see the PFR) conducted indicated that of the 143 miles of streambanks studied (71.5 river/stream miles) only 22.7 miles, or 16 percent of the streambanks were actively eroding. The studies also indicated that annual streambank erosion annually produces about 52,000 cubic yards of sediment. Of this 52,000 cubic yards of sediment, it is estimated that 47,000 cubic yards of sediment is transported to Cleveland Harbor and requires annual maintenance dredging. This volume of sediment represents about 5 percent of the total volume of sediment annually dredged. The studies also indicated that there were seven locations on the Cuyahoga River where the existing rate of annual streambank erosion was likely to produce a change in the course of the river (potential meander change). If these potential meander changes were to occur, they would introduce an additional 125,000 cubic yards of sediment into the river system. In addition, the studies indicated that damage to local roads and railroad facilities of the Baltimore and Ohio Railroad will occur in the future due to streambank erosion at these sites.

Initially a total of nine structural and/or nonstructural conceptual alternatives (including no action) were formulated to control streambank erosion within the study area. Preliminary evaluation and assessment of these conceptual alternatives indicated that only three alternatives warranted further consideration. In addition, the basis of comparison for these three alternatives was the no action (do nothing) plan. Based on additional evaluation and assessment, it was determined that the three alternatives warranting further study were not economically feasible and no overriding environmental or social benefits would be derived from implementation of these plans. Therefore, it was concluded that the "no action" plan was the appropriate course of action as regards streambank erosion control for the Cuyahoga River and its tributaries. In addition, it was concluded that the Third Interim Study on Erosion and Sedimentation should be terminated.

SUMMARY RESULTS OF UPLAND EROSION CONTROLS STUDIES

The purposes of the upland erosion control studies conducted for this study were to identify and quantify sources of upland erosion and to develop a series of management programs to control erosion in the upland study area (the 303 square-mile drainage basin of the Cuyahoga River between Independence (river mile 13.8) and Old Portage (river mile 40.25)).

U.S. Army Corps of Engineers. pg. 93.

Implementation of these management programs, must, however, be pursued by other (local) interests.

Results of the investigations conducted for this study show that erosion and sedimentation is a very serious problem in the upland area. For example, sheet and rill erosion (diffuse nonpoint sources) from critically eroding areas in the seven subwatersheds produce about 884,000 tons of soil loss annually. These critically eroding areas occur on only 27,000 acres, or 14 percent of the total area. All other areas within the seven subwatersheds produce an insignificant volume of soil loss and can be deleted from further consideration.

Of the 884,000 tons of soil loss produced from critically eroding areas in the seven subwatersheds studied, it is estimated that 551,000 tons is delivered to the Cuyahoga River system annually and requires maintenance dredging at Cleveland Harbor. This volume of sediment represents about 43 percent of the total volume of sediment dredged. Therefore, in order to significantly reduce dredging costs at Cleveland Harbor, an effective erosion control program must be implemented on these critically eroding areas.

Management programs were developed to control sheet and rill erosion on critically eroding areas for the seven subwatersheds studied. These management programs consisted of Best Management Practices (BMP's) which, based on Soil Conservation Service experience with similar type projects, are both effective in erosion control and economically justified (that is, local interests implementing the management programs will realize benefits equal to or greater than the cost of implementing these programs). The average cost to implement these management programs on critically eroding areas was estimated at $300 per acre.

Sediment produced from identifiable nonpoint sources of erosion (gully erosion and flood plain scour on disturbed areas) is also a significant problem in the upland area. For example, this study identified a total of 32 sites, comprising 587 acres, where gully erosion or flood plain scour is occurring within the study area. In addition, it is estimated that these sites produce about 138,000 tons of sediment per year that requires annual maintenance dredging at Cleveland Harbor (11 percent of the total volume dredged). These sites also produce an additional 48,000 tons of soil loss per year from gully erosion that does not enter the river system. However, this still represents a significant loss of a natural resource.

Management programs were developed to control the erosion on these 32 identifiable nonpoint sources of erosion. These management programs consisted of BMP's similar to those required to treat sheet and rill erosion. The average cost to implement these management programs was estimated at $2,800 per acre.

U.S. Army Corps of Engineers. pg. 94.